

STATE OF ALASKA

WILLIAM A. EGAN, GOVERNOR



Annual Performance Report

For

LAKE AND STREAM INVESTIGATIONS

A Study of a Typical Spring
Fed Stream of Interior Alaska

by

Gary A. Pearse

ALASKA DEPARTMENT OF FISH AND GAME

James W. Brooks, Commissioner

DIVISION OF SPORT FISH

Rupert E. Andrews, Director

Howard E. Metsker, Chief, Sport Fish Research

TABLE OF CONTENTS

	Page No.
ABSTRACT	1
RECOMMENDATIONS	3
OBJECTIVES	3
BACKGROUND	3
TECHNIQUES USED	4
FINDINGS	7
Water Quality	7
Species Present and Distribution	9
Standing Crop	10
Grayling Life History	12
Round Whitefish Life History	29
Silver Salmon Life History	44
Creel Census	47
LITERATURE CITED	49

RESEARCH PROJECT SEGMENT

State: ALASKA

Name: Sport Fish Investigations
of Alaska.

Project No.: F - 9 - 6

Study No.: G - III

Study Title: LAKE AND STREAM INVESTIGATIONS

Job No.: G - III - G

Job Title: A Study of a Typical Spring
Fed Stream of Interior Alaska.

Period Covered: July 1, 1973 to June 30, 1974.

ABSTRACT

Data collected during 1972 and 1973 as part of renewed studies of Interior Alaska spring-fed streams is presented. The study area, principally the Delta Clearwater River, includes several popular sport fisheries for Arctic grayling, Thymallus arcticus.

Water temperatures in the spring-fed systems ranged from 0.5°C to 8.5°C. High levels of hardness and alkalinity were recorded.

Main fish species present were Arctic grayling, round whitefish, Prosopium cylindraceum, and silver salmon, Oncorhynchus kisutch.

Estimates of standing crop for the Delta Clearwater River showed 6.7 kg per hectare for grayling and 56.9 for round whitefish. Standing crop estimates of round whitefish in two sections of the Tanana River averaged 84 kg per km.

Data are presented on interstream and intrastream migration patterns. Abundance estimates were determined by both the Schnabel and Schumacher-Eschmeyer methods, the latter showing an estimated 2,267 grayling and 13,611 round whitefish in the Delta Clearwater River.

Life history information regarding length frequencies and distribution, length-weight relationship, condition factors, age and sex composition, and maturity for Arctic grayling and round whitefish is presented.

Limited data on food habits and a faunal list are presented.

An estimated 3,322 silver salmon spawned in the Delta Clearwater River during 1973. Salmon escapement estimates for surrounding systems are also presented. Certain aspects of silver salmon life history are discussed.

RECOMMENDATIONS

It is recommended that this job be terminated with the exception of the following phases which should be incorporated into other existing jobs in the area:

1. Introduce young-of-the-year Arctic grayling in certain sections of the Delta Clearwater system.
2. Develop methods for increasing the sport harvest of round whitefish in the Tanana River drainage waters.
3. Complete a short-term food competition study between round whitefish and Arctic grayling.

OBJECTIVES

1. To determine fish species present, distribution, inter-stream and intrastream migration, and abundance in the Delta Clearwater system.
2. To determine life history information such as length, weight, condition, age, growth rate, sex, and maturity composition in the Delta Clearwater system.
3. To determine production of fish species within various sections of the Delta Clearwater system.
4. To determine spawning locations, timing and fecundity of fish species in the Delta Clearwater system.
5. Food habits studies will be conducted to determine distribution and species diversity of aquatic insects and the relationship to fish food preferences in the Delta Clearwater system.
6. To obtain information on effort, catch success, and sport fish harvest from anglers fishing the Delta Clearwater system.

BACKGROUND

Studies of typical Interior Alaska spring-fed streams were initiated in 1952 by the U.S.F.&W.S. as part of the Arctic grayling life history study. From 1952 to 1958 studies were conducted on age and growth, migration, food and spawning habits of grayling. The study emphasized migration habits of grayling within the Tanana River watershed and developed various tagging techniques. Results of these studies were presented as Quarterly Progress Reports of Federal Aid in Fish Restoration, F-I-R-1, to F-I-R-8.

In 1959, studies on the Delta Clearwater and nearby river systems were divided into the determination of stocks, migration (intrastream and interstream), and angler success. The above studies have been continued intermittently until the present and results published in the annual Department of Fish and Game Federal Aid in Fish Restoration Reports.

Angler demand for stream fishing continues to be substantial, although some fishing pressure has been diverted toward the managed lakes in the area.

The present program was designed to bring to date information on the status of fish species present in the Delta and Richardson Clearwater rivers, and other spring-fed systems in the Tanana drainage (Figure 1).

The Delta Clearwater River, the main study area, is situated approximately 8 miles northeast of Delta Junction (Figure 2). Access is either through two roads which branch off the Alaska or Richardson highways, or up the Tanana River from Big Delta. The Delta Clearwater River drains an area of approximately 350 square miles, drawing heavily on groundwater as its source. Fairly constant levels, flows, and water temperatures characterize this and other Interior Alaskan spring-fed systems. The other study area, the Richardson Clearwater River, drains an area of approximately 48 square miles and possesses similiar qualities. It enters the Tanana River from the west approximately 40 miles below the confluence of the Delta and Tanana rivers.

TECHNIQUES USED

Fish species studied for population, migration, and life history data were captured either by an alternating current shocker boat described by Van Hulle (1968) and Roguski and Winslow (1969), or by using a 50' seine. Rearing species were captured with a back-pack mounted, pulsed DC electro-shocker.

Number FD-67 (Floy Tag Company) internal anchor tags were inserted in the dorsal musculature on fish over 150 mm.

Migration was determined from tagged fish recaptures. Population estimates were accomplished by both the Schnabel and Schumacher-Eschmeyer mark and recapture methods (Ricker, 1958). (The estimates of standing crop were calculated by separating the population estimate for an area into the number of fish in each 10 mm length group present. The average weight for each 10 mm length group multiplied by the estimated number summed for all length groups gave the standing crop estimate.)

A random subsample was autopsied for life history information. Fork lengths in millimeters, weights in grams, stomach, and gonad samples were obtained.

The Delta Clearwater River was divided into uniform sections to facilitate sampling and habitat studies.

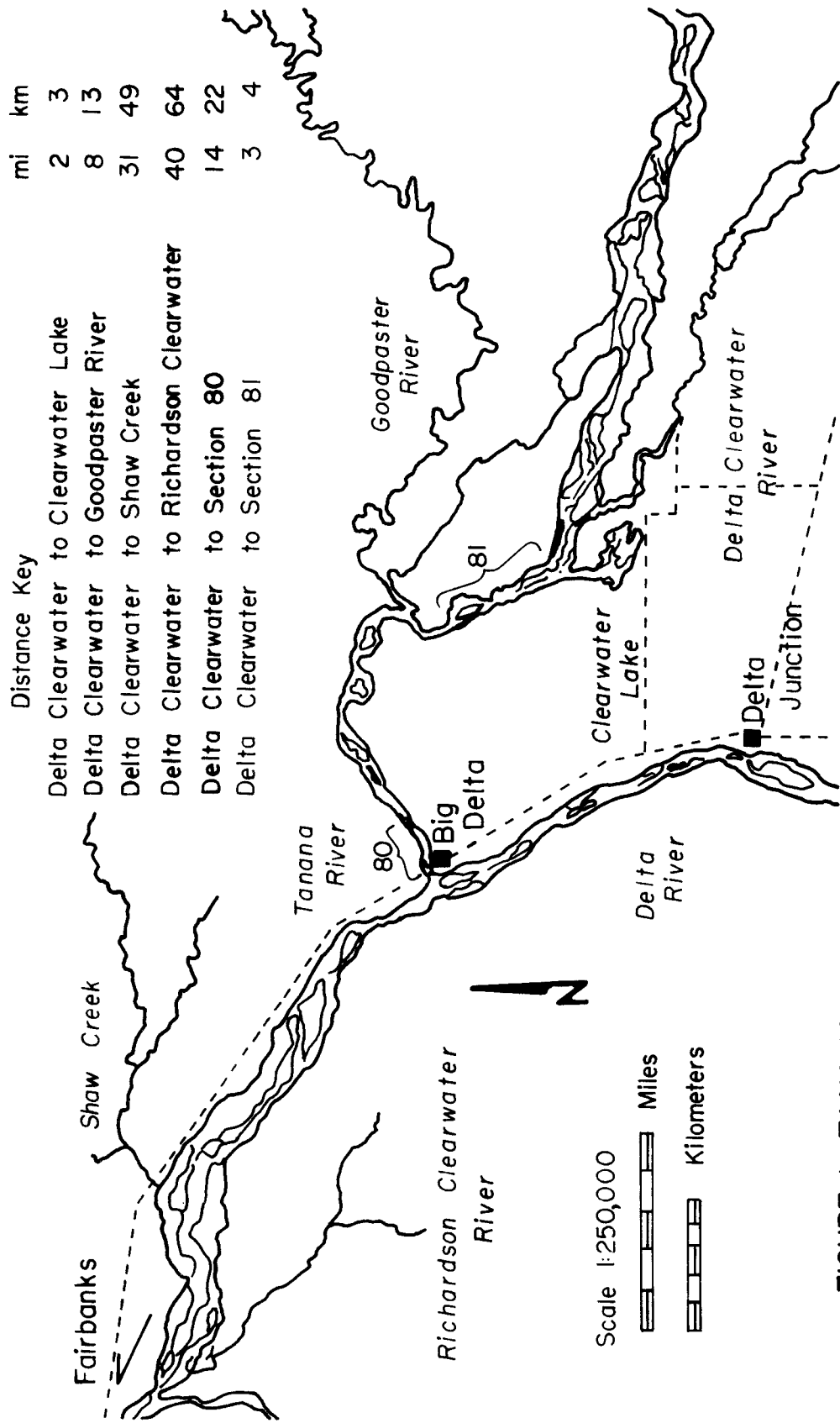


FIGURE 1. TANANA-CLEARWATER STUDY AREA

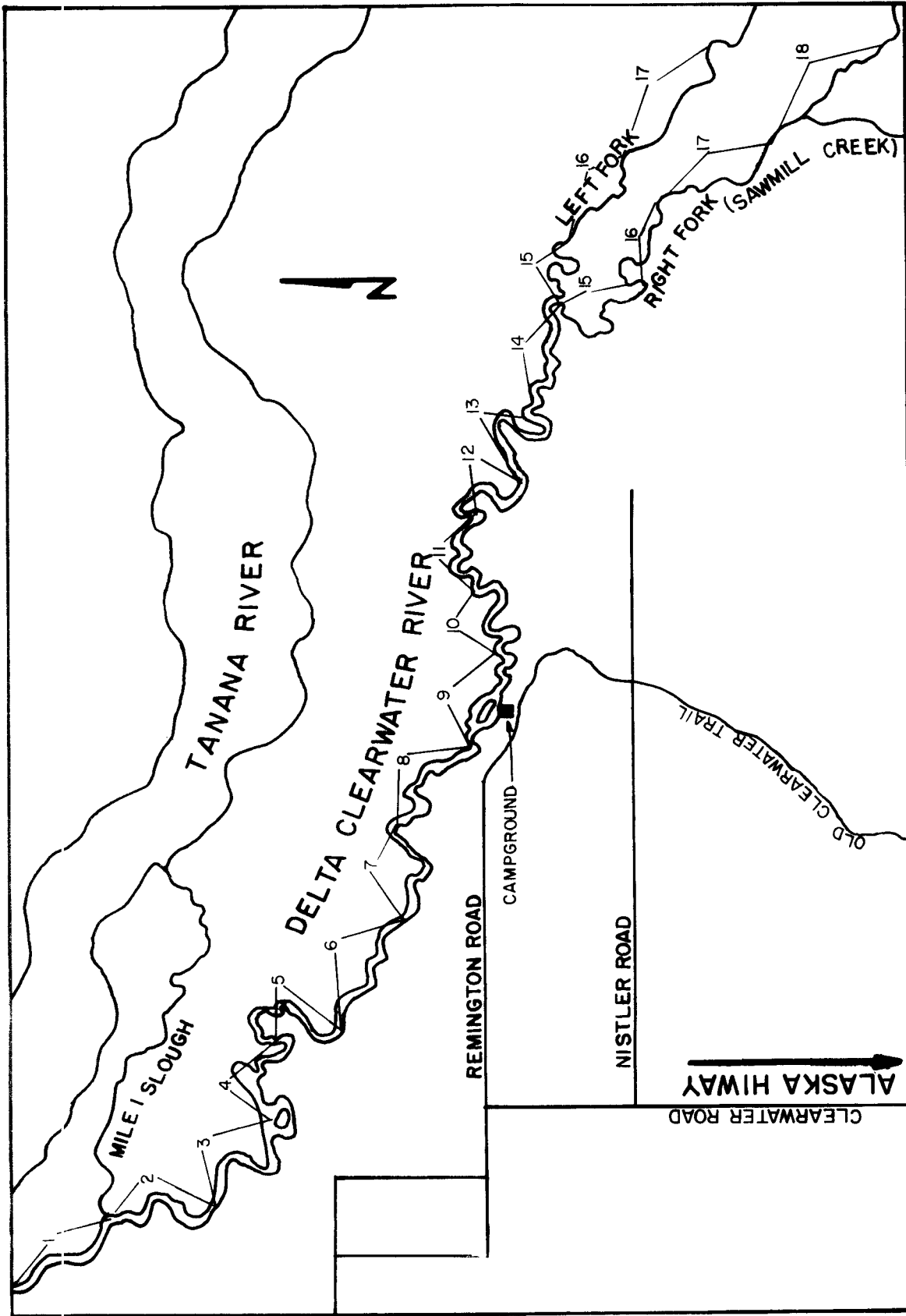


FIGURE 2. DELTA CLEARWATER RIVER AND SAMPLE SECTIONS

Spawning locations and timing were determined visually. Aquatic insects were collected by Surber sampler and manual methods.

Angler interviews were conducted to determine catch and effort.

Water chemistry determinations were made with a Hach AL-36 B drop titration kit.

Water velocities were determined by the velocity head rod method.

Scales from captured fish were taken for age determination. The scales were cleaned, mounted on gummed cards, and heat pressed onto acetate sheets. An Eberbach console microprojector was used for determining the age of sampled fish species. Grayling scales were aged along the dorsal radius, while round whitefish and silver salmon were aged along the anterior field.

Measurements of total scale radius and focus to annuli values were taken from randomly sampled grayling and round whitefish scales to determine back-calculated lengths. The linear formula used was that of Rounsefell, 1953, p. 324, and employed the formula: $L^1 = C + \frac{S^1}{S} (L - C)$

where L^1 = Length at annulus formation - unknown
 S^1 = Scale radius from focus to annulus
 L = Length at capture
 S = Total scale radius
 C = Length at scale formation

Tack (1971) reports grayling first form scales at a length close to 35 mm. From a sample of rearing round whitefish taken on the Goodpaster River in mid-July of 1973, it was shown that the largest size at which scale formation occurred was also 35 mm. Therefore, this length at scale formation (C) was taken for both species. Back calculations were carried out on a Friden 1155 computer.

FINDINGS

Water Quality

The yearly water quality and temperature values for the Delta Clearwater River are shown in Table 1. Temperatures ranged from a winter low of 0.5°C to a summer high of 8.5°C. Daily warming fluctuations induced by cloud cover and stream section were common, with the warmer water found further downstream. Winter icing occurs only in slow stretches below section 14, and in some lower sections of the left fork. Dissolved oxygen, pH, and CO₂ values remain fairly stable and always acceptable. Hardness and alkalinity average 157 ppm and 140 ppm respectively in the main river. The average hardness and alkalinity in the left fork (188 and 165 ppm) are higher than in the right fork (137 and 143 ppm). The springs that feed the headwaters of the right fork maintain a constant 2°C temperature with dissolved oxygen at 8 ppm, hardness and alkalinity at 188 and 171 ppm, and CO₂ at 25 ppm year round. The main water source is the Granite Mountains to the south.

TABLE 1. Water Quality and Flows From the Delta Clearwater River, 1972-1973.

Year	Month	H ₂ O (°C) Temp.	DO (ppm)	pH	Hardness (ppm)	Alkalinity (ppm)	CO ₂ (ppm)	Flows (cfs)
1972	Oct.*	2.0	17	8.0	188	171	20	--
1972	Oct.**	1.0						
1972	Dec.***	1.0						
1973	Jan.***	1.0	20	8.5	137	120	15	
1973	Feb.***	0.5	19	8.0	154	137	15	
1973	Mar.**	2.0	12	7.7	171	137	10	
1973	Mar.***	1.5	21	8.0	171	154	15	
1973	Mar.****	3.0						
1973	Apr.*	3.7	18	8.0	188	154		80
1973	Apr.**	4.1	20	8.0	102	137		336
1973	Apr.***	3.6						
1973	Apr.****	5.7						
1973	May**	5.3						
1973	May***	5.4						
1973	June*	6.5	11	8.5	188	171	15	101
1973	June***	8.5	13	8.7	171	137	10	710
1973	June****	14.0						
1973	July**	7.0						
1973	July***	8.5	12	8.4	154	154	15	
1973	Aug.**	4.5						
1973	Sept.***	3.5						
1973	Oct.*	1.5						
1973	Oct.**	2.0						
1973	Oct.***	2.0						
1973	Nov.**	2.0						

*Left Fork
 **Right Fork
 ***Main River
 ****Mile 1 Slough

Table 2 shows similar water conditions found in the Richardson Clearwater River.

The high values for hardness and alkalinity, constant temperatures and generally year round ice-free conditions make the Delta Clearwater and similar stream potentially excellent fish producers.

TABLE 2. Water Quality and Flows From the Richardson Clearwater River, 1973.

Month	H ₂ O Temp. (°C)	DO (ppm)	pH	Hardness (ppm)	Alkalinity (ppm)	CO ₂ (ppm)	Flows (cfs)
August	6.0	12	8.5	137	137	5	340
October	3.5	11	8.0	171	137	5	---

Species Present and Distribution

Fish species either observed or captured in the Delta Clearwater River consist of Arctic grayling, Thymallus arcticus; round whitefish, Prosopium cylindraceum; humpback whitefish, Coregonus pidschian; least cisco, C. sardinella; longnose sucker, Catostomus catostomus; slimy sculpin, Cottus cognatus; and silver salmon, Oncorhynchus kisutch. Northern pike, Esox lucius and chum salmon, O. keta have been reported in the lower sections, however none were observed.

In 1973, round whitefish were first observed in Section 1 and in Mile 1 Slough on April 10. Small numbers of grayling were also present. None of these species were observed upstream prior to that date. These fish entered from the Tanana River, a possible overwintering habitat. The water temperature had by that time risen to 3.6°C from a February low of 0.5°C. Both of these species were present in mid-December the previous year, and apparently left the stream in the interim period.

Round whitefish in the Delta Clearwater River were either captured or observed in Section 1 through 14 of the main river, 15 through 17 of the left fork and 15 through 20 of the right fork. Grayling were also present in these sections. The numbers in the left fork were minimal compared with the right fork for both species.

Silver salmon rear in the Delta Clearwater River for up to two years, at which time they smolt and leave. Adults return to spawn the following year in early September.

Silver salmon occupied rearing habitat in spring areas and stream margins throughout the entire Delta Clearwater River system. They were captured as far up as the springs which feed the headwaters of the river, approximately 20 miles from the mouth. Adult salmon use the entire system as a spawning area.

Chum salmon utilize Section 1 and Mile 1 Slough as a spawning area.

Least cisco and humpback whitefish appeared as incidental captures in mid-May. They were absent in future sampling efforts and were never captured above Section 2.

During a two week period beginning July 23, approximately 500 suckers were observed in the lower three stream sections. Water temperature was 8.5°C.

There is no information on the duration of sculpin presence or distribution in the Delta Clearwater River.

Round whitefish, grayling, silver salmon, and chum salmon were either observed or captured in the Richardson Clearwater River.

Round whitefish and grayling were found only in the lower 4 miles of the Richardson Clearwater River. Silver and chum salmon were observed to range 3 miles further upstream.

Standing Crop

Estimates of standing crop were derived for Arctic grayling and round whitefish in the Delta Clearwater River and for round whitefish in Sections 80 and 81 of the Tanana River.

Table 3 presents the standing crop for grayling in the Delta Clearwater River. The date of the population estimate (8/16/73) removes the effect of previous angler induced mortality.

Table 4 presents a similar estimate for round whitefish in the same system. Round whitefish are six times as abundant and represent 8.46 times the biomass of grayling in the Delta Clearwater River. The total biomass of round whitefish and grayling in this river equals 7,569 kg or 16,690 pounds. This equals 63.6 kg per hectare or 56.6 pounds per surface acre.

Estimates of round whitefish standing crop in Sections 80 and 81 of the Tanana River are presented in Table 5. No data are available on river surface area.

TABLE 3. Standing Crop Estimate, Arctic Grayling, Sections 2-17, Delta Clearwater River, August 16, 1973.

Surface Area		Population Estimate*	Number/Surface Area		Standing Crop**	
<u>Hectares</u>	<u>Acres</u>		<u>Hectares</u>	<u>Acres</u>	<u>kg/hectare</u>	<u>lb/acre</u>
119	295	2,267	19	8	6.7	5.9
					<u>kg/km.</u>	<u>lb/mile</u>
					32.0	110.3

*Schumacher-Eschmeyer estimate

**800 kg or 1,764 pounds.

TABLE 4. Standing Crop Estimate, Round Whitefish, Sections 2-17, Delta Clearwater River, August 15, 1973.

Surface Area		Population Estimate*	Number/Surface Area		Standing Crop**	
<u>Hectares</u>	<u>Acres</u>		<u>Hectares</u>	<u>Acres</u>	<u>kg/hectare</u>	<u>lb/acre</u>
119	295	13,611	114	46	56.9	48.5
					<u>kg/km</u>	<u>lb/mile</u>
					270.8	932.8

*Schumacher-Eschmeyer estimate

**6769 kg or 14,926 pounds

TABLE 5. Standing Crop Estimates, Round Whitefish, in Certain Sections of the Tanana River, April, 1973.

River Section	Population Estimate*	Section Length		Standing Crop		Total (kg)
		km	mi.	kg/km	lb/mi.	
80	3,378	3.2	2	306.1	1,079.5	979.4
81	14,662	6.0	4	1,128.2	3,731.3	6,768.9

*Schumacher-Eschmeyer estimate

Grayling Life History

Intrastream Migration:

The summary of grayling interstream migrations based on 1973 tagged fish recaptures are shown in Table 6. The trend of grayling to migrate within the study area with certain specific interchanges follows a pattern similar to that summarized by Shallock and Roguski (1967).

TABLE 6. Interstream Grayling Migration Summary, Tanana Drainage, 1973.

Location Tagged	Date Tagged	Location Recaptured	Date Recaptured	Movement	
				mi.	km.
Delta Clearwater R.	5/16/73	Clearwater Lake	7/7	12	19
Delta Clearwater R.	5/18/73	Clearwater Lake	7/16	4	6
Delta Clearwater R.	6/26/73	Goodpaster River	9/15	33	53
Goodpaster River	8/21/70	Clearwater Lake	7/8	6	10
Goodpaster River	8/23/72	Richardson Clear. R.	7/15	30	48
Goodpaster River	5/9/73	Delta Clearwater R.	6/29	19	30
Goodpaster River	5/9/73	Delta Clearwater R.	7/15	19	30
Chena River	7/29/68	Richardson Clear. R.	8/1	90	144
Lower Tangle Lake	6/28/69	Delta Clearwater R.	7/3	111	178

The Goodpaster River and Shaw Creek are spawning areas, whereas few grayling reproduce in either of the Clearwater River systems. Hence, rearing grayling emigrate from these spawning rivers and enter the Tanana River, whereupon a migration to summer feeding areas, such as the Delta and Richardson Clearwater rivers, takes place.

It has been previously shown that fish migrating to another system after tagging are most likely to be recovered the following year.

Of interest is the recapture of a grayling in the Richardson Clearwater River that had been tagged five years previously in the Chena River, near Fairbanks. This amounted to a movement up the Tanana River of 144 km (90 mi.). The recapture in the Delta Clearwater River of a grayling tagged in 1969 in Lower Tangle Lake, that moved down the Delta River, then up the Tanana River, emphasized long range movements.

A single grayling tagged in the Delta Clearwater River in June 1973 was later recaptured up the Goodpaster River the following September.

Intrastream Migration:

Table 7 summarizes the mark and recapture efforts on Arctic grayling in the Delta Clearwater River during 1973. Of the 411 fish tagged, 65 (16%) were later recaptured. Anglers caught a minimum of 23 (6%). The number tagged amounts to approximately 20% of the estimated number of grayling in the stream (2,267).

TABLE 7. Mark and Recapture Summary of Grayling Tagged in the Delta Clearwater River, 1973.

Total Number Tagged = 411

Recapture Summary

<u>Method</u>	<u>Number (%)</u>		<u>Location</u>
Electroshocker boat	39	9	Delta Clearwater River
Returned Angler Catch	<u>23</u>	<u>6</u>	
	62	15	
Electroshocker Boat	2	0.5	Clearwater Lake
Returned Angler Catch	<u>1</u>	<u>0.2</u>	Goodpaster River
	3		
Total	65	16	

General movement trends are shown in Figure 3. As mentioned above, grayling entered the Delta Clearwater along with the round whitefish in early April. These fish were all less than 290 mm in fork length. Of those tagged in April (15), only one was later recaptured upstream. There were few recoveries of grayling tagged in May. However, those grayling tagged in June showed a major downstream movement when recaptured in July, August, and October. Whether this movement was normal or induced by capture and handling shock is not known. The small number of recaptures precludes a statement of conclusive trends, especially with the possibility of upset from sampling.

Visual observations tend to show that the smaller grayling entered the river in April. Larger (greater than 300 mm) grayling entered in mid-May and June and migrated upstream to establish themselves in prime feeding habitat in Sections 9 through 17. Observations in late August or September failed to show the abundance of these fish in the upper stream sections, suggesting a downstream trend of movement in the fall. Some grayling lingered through mid-winter (1972), however all were absent in March of the following spring (1973).

A total of 71 grayling was tagged in the Richardson Clearwater River the first two days in August, but no effort was made to assess intrastream movement.

Abundance:

Estimates of grayling abundance in the Delta Clearwater River by the Schnabel and Schumacher-Eschmeyer methods are shown in Table 8. Low recapture success, i.e., 12 recaptures for the June and 15 for the August estimates, necessitated the two separate estimates. The June estimate, which focused on the relative concentration of grayling in the upper stream sections, totaled 1,451 for the Schnabel method and 1,454 for the Schumacher-Eschmeyer method.

TABLE 8. Estimates of Grayling Abundance in the Delta Clearwater River, 1973.

Sample Dates	River Sections	Schnabel Estimate	95% CI	GR per mi. km.	Schumacher-Eschmeyer Estimate	95% CI	GR per mi. km.
6/20-29	10-17	1,451	961-4,311	181 132	1,454	1,189-1,871	182 121
8/13-16	2-17	2,169	1,489-5,188	136 87	2,267	1,405-5,865	142 91

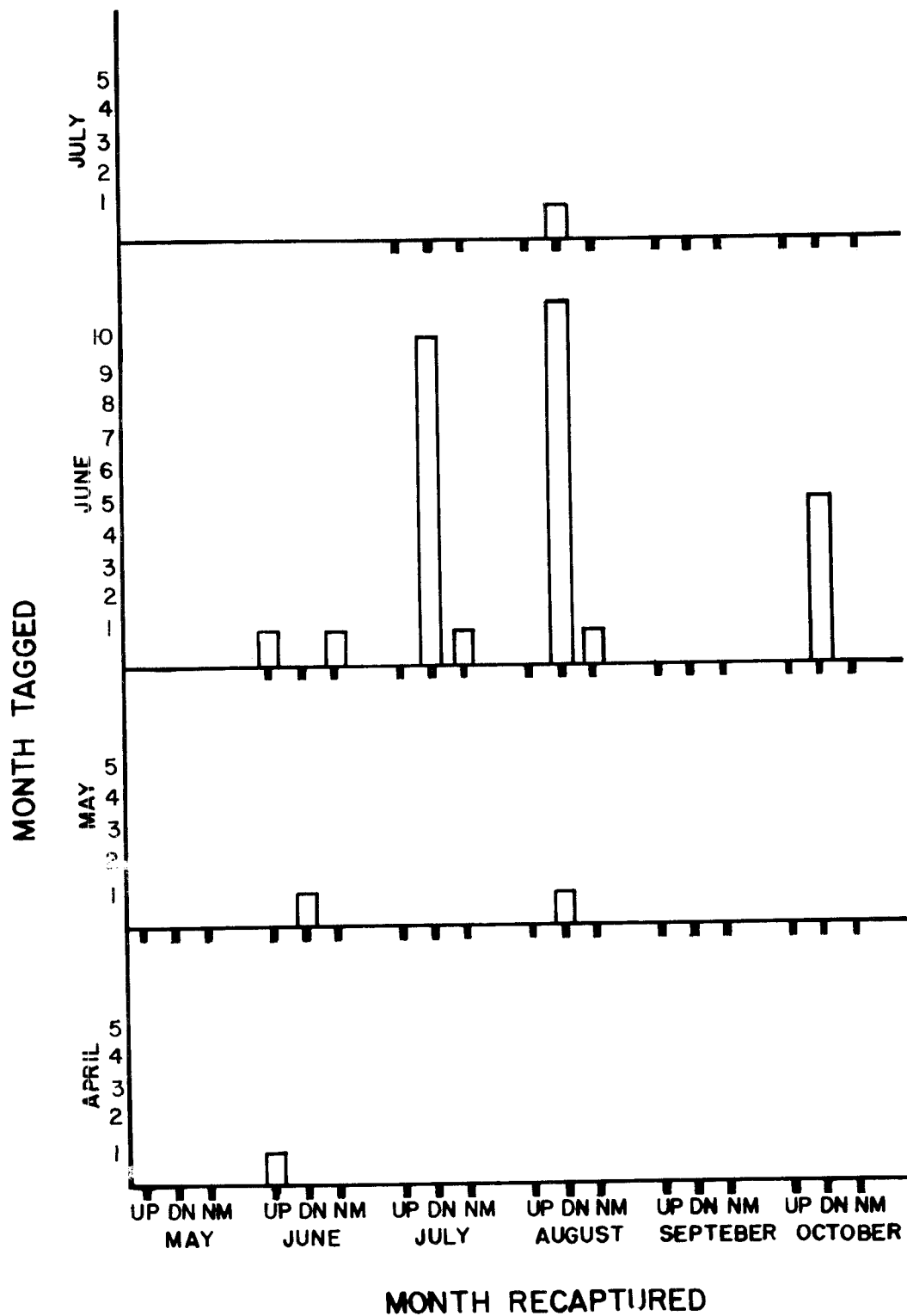


Figure 3. The Restricted* Number of Grayling Recaptured that Moved Up (UP), Down (DN), or Showed No Movement (NM) in the Delta Clearwater River, 1973.

*Excludes Recaptured within a Week of Previous Capture

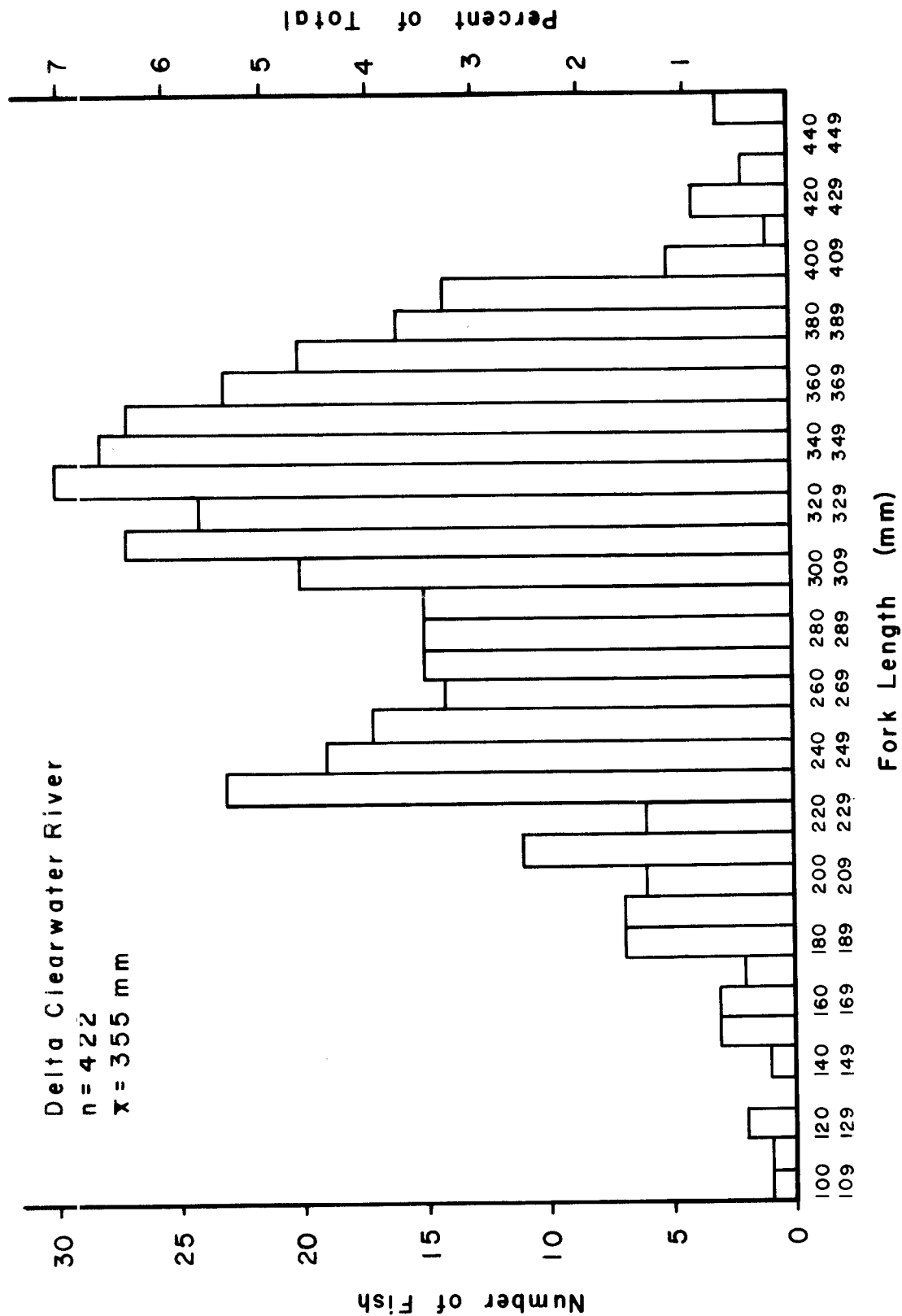


FIGURE 4. LENGTH FREQUENCY OF ELECTRO-FISHED ARCTIC GRAYLING FROM THE DELTA CLEARWATER RIVER, 1973.

The population estimate (2,267) for the majority of the Delta Clearwater system barely exceeds the total number of grayling tagged (2,160) in 1960 (Reed, 1964).

Length Frequencies:

The length frequency distribution of 422 grayling captured during 1973 in the Delta Clearwater River is shown in Figure 4. The mean length is 355 mm. Except for peaks at 230 - 250 mm, the distribution of fish lengths is smooth to the peak at 330 - 339 mm (7% of total). After this group, the numbers of larger fish decrease rapidly. This may be due to angler pressure and selectively, or natural mortality. However, the steepness of the decline would not favor the latter.

Table 9 presents comparative length frequencies of grayling sampled in the Delta Clearwater River from 1960 to 1973. Fish sampled in 1973 differed in length group abundance from those captured in previous years. Length groups from 165 - 264 mm were at a lower percentage, length group percentage for 265 - 314 mm fish was normal, and fish above 315 mm fork length comprised a higher percentage than recorded before.

The reason for the change in length frequencies is not readily apparent. The sampling method used in 1973 (Electroshocker boat) may have been selective for larger sizes as opposed to hook and line or seines used in earlier years.

The length frequency distribution shown in Figure 5 for fish captured in the Richardson Clearwater River displays marked gaps in the length groups and a general absence of fish greater than 319 mm in fork length. The sample size (85) may not reflect the actual condition as would one with more samples. However, large fish (greater than 319 mm) were absent, as were fish with a fork length less than 220 mm.

Length - Weight Relationships:

The length-weight relationship of Arctic grayling captured in the Delta Clearwater River during two sample periods is shown in Figure 6. The standard formula of $\text{weight} = a \times (\text{fork length})^n$ was used; values for a and n being determined empirically. The concept of weight versus length being a cube function is followed closely. Grayling captured in May ($N = 27$) weighted less at a given length than grayling captured later in the summer ($N = 48$). The weight increase was due to good food availability and gonad development.

Condition Factors:

The condition factors were determined by the formula $K = \text{weight} \div \text{fork length}^3 \times 10^5$ and are shown for grayling from the Delta Clearwater River in Table 10. The weights used were those estimated by the

TABLE 9. Length Frequency of Grayling, Captured in the Delta Clearwater River, 1960-1975.

Length Class (mm)	1960		1961		1962		1963		1964		1965		1966		1973		Mean Percent 1960-66
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	
165-214	418	(20.1)	61	(19.1)	371	(43.2)	51	(10.4)	106	(29.3)	58	(20.6)	69	(17.9)	30	(7.4)	<u>21.6</u>
215-264	923	(44.1)	105	(32.8)	544	(50.1)	155	(31.6)	93	(26.7)	96	(43.2)	224	(58.0)	89	(21.6)	<u>39.5</u>
265-314	564	(26.9)	75	(23.4)	116	(10.7)	193	(39.3)	96	(26.5)	90	(32.0)	77	(20.0)	80	(19.4)	<u>25.5</u>
315-364	165	(7.9)	68	(21.3)	45	(4.1)	69	(14.1)	48	(13.3)	25	(8.9)	14	(3.6)	138	(33.4)	<u>10.5</u>
365-414	23	(1.1)	10	(3.1)	10	(0.9)	22	(4.5)	17	(4.7)	12	(4.3)	2	(0.5)	67	(16.2)	<u>2.7</u>
415-464	<u>1</u>	<u>(0.05)</u>	<u>1</u>	<u>(0.3)</u>	---	---	<u>1</u>	<u>(0.2)</u>	<u>2</u>	<u>(0.6)</u>	-----	-----	-----	-----	<u>9</u>	<u>(2.0)</u>	<u>0.2</u>
	2,094		320		1,086		491		362		281		386		413		

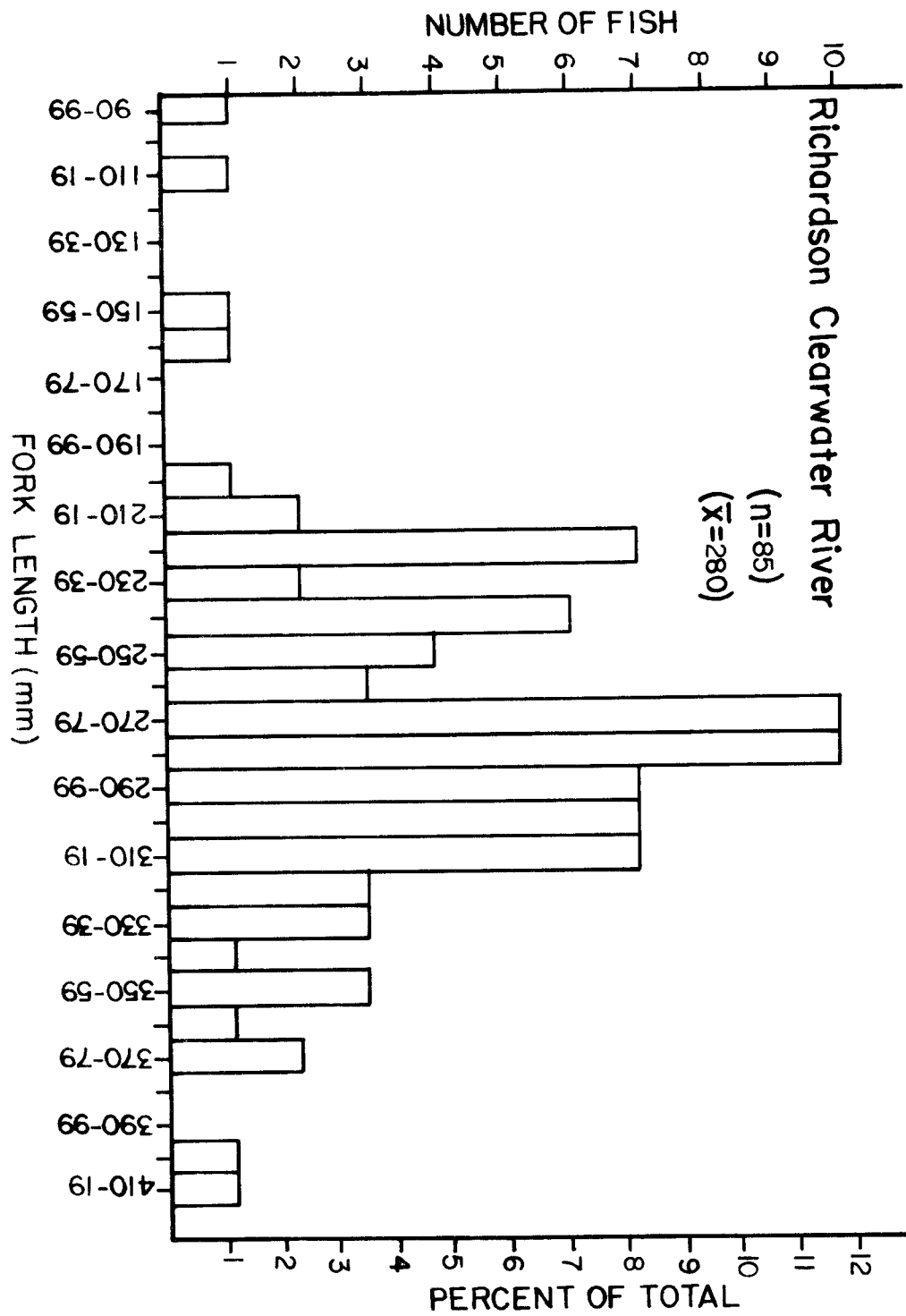


Figure 5. Length Frequency of Electrofished Arctic Grayling, Richardson Clearwater River, 1973.

length-weight relationship described in Figure 6; fork lengths were taken at the mid-point of 20 mm groups. Hence, the K values describe calculated, average condition values. The higher the K value the greater the calculated weight at a given length.

TABLE 10. Relative Condition Factors ($K = W/FL^3 \times 10^5$) for Arctic Grayling Samples in the Delta Clearwater River, 1973.

Length Group (mm)	Sampled Period	
	4/11-16	5/14-10/10
100-119	0.954	1.091
120-139	0.947	1.095
140-159	0.943	1.099
160-179	0.938	1.103
180-199	0.934	1.107
200-219	0.929	1.110
220-239	0.926	1.113
240-259	0.923	1.115
260-279	0.920	1.117
280-299	0.916	1.120
300-319	0.915	1.122
320-339	0.913	1.124
340-359	0.911	1.126
360-379	0.909	1.127
380-399	0.907	1.129
400-419	0.905	1.130
420-439	0.903	1.132
440-459	0.901	1.133

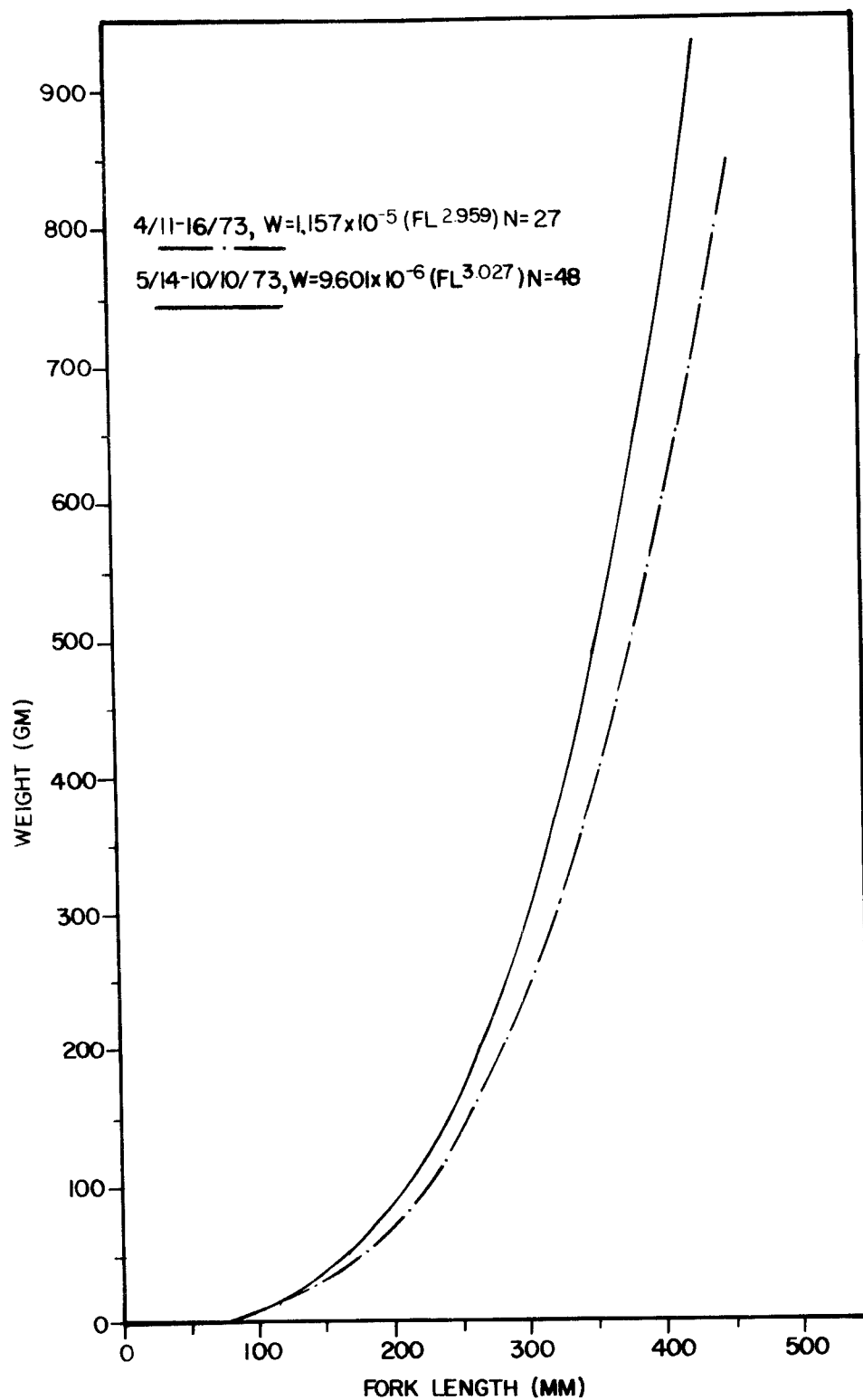


Figure 6 Length-Weight Relationship of Arctic Grayling (Sexes Combined) Delta Clearwater River, 1975.

In the April grayling sample, condition factors decreased with increasing fork length. A possible reason is that the larger, potential spawning sizes (greater than 300 mm) lose more weight proportionally in reproductive products than smaller fish lose in just a winter feeding. The larger grayling would have spawned just prior to capture. Grayling captured during the summer period showed an increase in weight for a given length; the increase being greater for larger fish.

TABLE 11. Age Composition and Observed Length-Age Relationships of 237 Arctic Grayling Electrofished in the Delta Clearwater River, 1975.

Fork Length (mm)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI+
100-119	3										
120-139		1									
140-159											
160-179		4	2								
180-199			6								
200-219			8	1							
220-239			14	8							
240-259			7	12		1					
260-279			1	15	4	1					
280-299				10	7						
300-319				5	13	2					
320-339				2	10	19	4				
340-359					4	20	9				
360-379						12	10	3			
380-399						1	8	1			
400-419						1		2			
420-439								2			1
440-459								2		1	
No. of Fish	3	5	38	53	38	57	31	10		1	1
Age Comp. (%)	1.3	2.1	16.5	22.4	16	24.1	13.1	3.8		0.4	0.4
Avg. Length (mm)	115	160	222	268	311	346	366	402		456	425
S.D.	6	19	24	26	23	22	25	29		---	---

Age Composition and Lengths at Age:

The age composition and observed length-age relationship of 237 Arctic grayling from the Delta Clearwater River is shown in Table 11. Sample sizes of age II and younger grayling are minimal, as are those of age IX and older. The almost total absence of recruitment within the Delta Clearwater system means that fish presence is due solely to immigration. Therefore, the age III fish represent the first influx of grayling that have left rearing habitat elsewhere. By age VIII, grayling are reduced in numbers through fishing and natural mortality.

Table 12 for the Richardson Clearwater grayling depicts the similar composition and length relationship as shown above. There is an almost complete absence of age II and younger fish. However fish in the older age classes decrease in number of age VI fish as opposed to decrease at age VIII in the Delta Clearwater. This absence of larger fish is also shown in Figure 5. The average calculated size of Richardson Clearwater grayling at age IV and older is less than that of similarly aged grayling captured in the Delta Clearwater River.

Back-Calculated Lengths at Age:

Due to the absence of younger age groups in both grayling and whitefish sampled, back-calculated lengths were computed to supplement the empirical data above. The body-scale relationship for both grayling and round whitefish was plotted and indicated a linear relationship.

Back-calculated lengths for grayling taken in the Delta Clearwater River are presented in Table 13. Average annual growth increments are also presented. Growth increments begin a decline after age III and stabilize by age VI. Back-calculated lengths agree closely with empirical age data in Table 11.

Richardson Clearwater grayling back calculated lengths are shown in Table 14. Annual growth increments decrease after age III.

Figure 8 shows the comparison of back calculated fork lengths and growth increments by age for grayling in the Delta Clearwater and Richardson Clearwater rivers. The mean fork length at any age is greater for Delta Clearwater grayling, as are annual growth increments below age VI.

Length Distribution:

The length distribution of Arctic grayling by stream section for the Delta Clearwater River is presented in Table 15. Assuming catch rate is proportional to relative numbers, the sample size per section may index relative abundance within limits. Grayling less than 300 mm in fork length comprised the lower river catch through section 4. The size distribution in Sections 5 through 12 consists of larger fish in the 200 - 400 mm fork length range. Main river Sections 13 and 14, plus 15 through 17 of the right fork, contained by far the highest percentage of large grayling.

Table 12. Age Composition and Observed Length-Age Relationships of 75 Arctic Grayling Electrofished in the Richardson Clearwater River, 1973.

Fork Length (mm)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI+
90-91	1										
110-119	1										
120-139											
140-159	1										
160-179			1								
180-199											
200-219			3								
220-239			6	1		1					
240-259			2	6	2						
260-279			1	7	4						
280-299				7	9						
300-319				1	8	2					
320-339					2	3	1				
340-359					1	1					
360-379						1	1				
380-399											
400-419										1	
420-439											
No. of Fish	3	0	13	22	26	8	2	0	0	1	
Age Comp. (%)	4.0	0	17.3	29.3	34.7	10.7	7.0	0	0	1.3	
Avg. Length (mm)	121	0	226	271	295	321	348	0	0	412	
S.D.	33	0	25	20	23	42	44	---	---	---	

Table 16. Back Calculated Length at Each Year of Life of Arctic Grayling, Delta Clearwater River, 1973.

Age At Capture	N	L ₁	Mean Fork Length At Annulus Formation (mm)							
			L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈	L ₉ L ₁₀ L ₁₁ +
I	1	88								
II	1	86	127							
III	2	95	145	199						
IV	18	101	151	211	260					
V	20	96	161	220	271	307				
VI	28	98	158	217	268	308	340			
VII	20	96	152	210	257	299	336	361		
VIII	3	93	144	197	239	282	315	349	375	
IX	1	101	147	193	247	292	332	349	417	459
X	0									
XI	0									
	94									
Weighted Mean (mm)	97	155	214	263	304	337	359	386	459	
Length (in)	3.8	6.1	8.4	10.4	12.0	13.3	14.1	15.2	18.1	
Avg. Annual (mm)	97	58	59	49	41	33	22	27	73	
Growth Increment (in)	3.8	2.3	2.3	2.0	1.6	1.3	0.8	1.1	2.9	

Table 14 Back-Calculated Length (mm) at Each Year of Life of 61 Arctic Grayling, Richardson Clearwater River, 1973.

Age At Capture	n	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈	L ₉	L ₁₀	L ₁₁ ⁺
I	3	100										
II	1	91	153									
III	12	92	141	201								
IV	20	88	148	198	240							
V	19	93	139	190	229	263						
VI	5	93	143	186	226	259	287					
VII	1	118	183	234	287	317	332	355				
VIII	--	---	---	---	---	---	---	---				
IX	1	86	135	180	237	276	306	331	367	385		
X	--	---	---	---	---	---	---	---	---	---		
XI	--	---	---	---	---	---	---	---	---	---		
Weighted Mean Length		93	146	199	235	265	296	343	367	385		
Mean Annual Growth Increments		93	53	53	36	30	31	47	24	18		

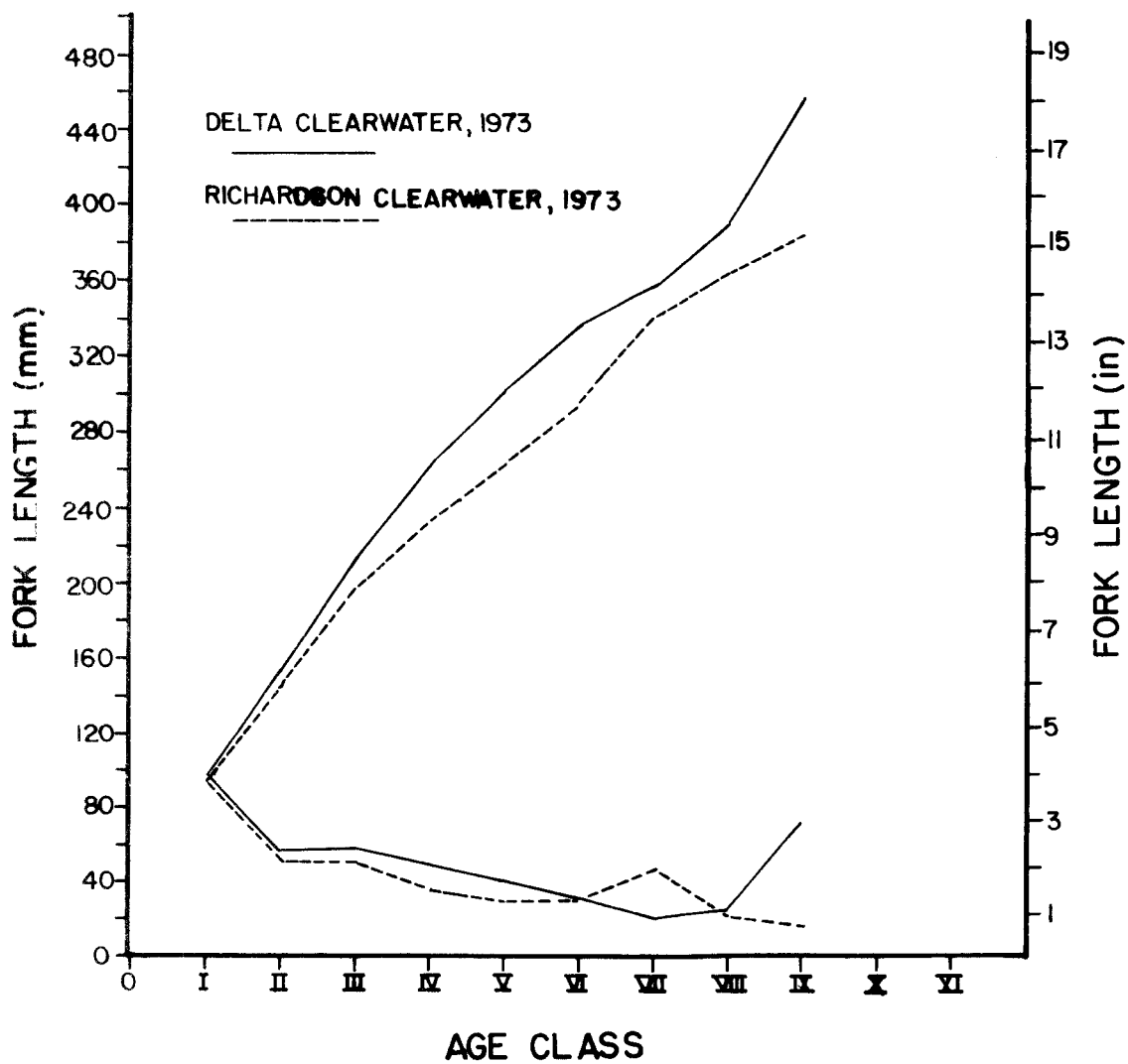


FIGURE 8. Back Calculated Fork Lengths, Increments, Grayling, Delta Clearwater and Richardson Clearwater Rivers, 1973.

Table 15. Percent Occurrence by Fork Length for Arctic Grayling Sampled in the Delta Clearwater River, June 20 to July 5, 1973.

Fork Length (mm)	River Section																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15*	16*	17*
50-99																	
100-149		25		100	17										2		
150-199		25							11				6				
200-249					49			17	56				14		2		
250-299		50	100		17	56	66	56	20		17	20	23	10	8		2
300-349					17	24	34	17	60	22	58	20	34	42	35	42	50
350-399						15			20	11	25	60	20	38	47	47	43
400-449													3	10	6	11	5
Sample Size	4	2	2	2	6	7	6	6	5	9	12	5	35	21	51	19	65
*Right Fork																	

These data on distribution were also confirmed by both visual and angler contact methods.

Sex Compositions:

Of 57 grayling autopsied from the Delta Clearwater River, males comprised 44%, and females 56%, of the sample. The small sample size prevents any direct analysis of composition by age group.

Data collected for maturity analysis yielded unclear results. This was due to the small sample size and the fact that there is little evidence to indicate many mature grayling spawn in these systems.

Spawning Locations and Timing:

Data collected to date fails to indicate a major spring spawning run of Arctic grayling into the Delta Clearwater River. No ripe pre-spawning adults were captured during the 1972 - 1973 field season. A check of spring angler catch also failed to turn up any pre-spawners. However, in sampling a spring area in Section 6 on 7/25/73 with a back-pack DC shocker, nine young-of-the-year grayling were captured. Their mean length was 62 mm, with a range of 54 - 68 mm. Rearing silver salmon were also captured in this spring.

Grayling that had recently spawned were captured as early as mid-May, with the influx of larger, mature grayling completed by mid-June.

Obviously, some grayling do indeed successfully spawn in the Delta Clearwater River. However, no other rearing grayling were captured in all the areas sampled.

Round Whitefish Life History

Interstream Migration:

A summary of round whitefish tagged and recaptured in 1973 is shown in Table 16. Of 657 tagged in Section 80 (Figure 1), three (0.4%) moved upstream to the Delta Clearwater, and two (0.3%) were later recaptured downstream in the Richardson Clearwater River. This suggests both small up and downstream summer dispersions. Two were caught by anglers in the tagging area during the summer. Of the 904 tagged in section 81, 53 (6%) were later recaptured immediately upstream in the Delta Clearwater, while only 1 (0.1%) was recaptured downstream in the Richardson Clearwater. Round whitefish tagged in Sections 80 and 81 probably overwinter in these areas of the Tanana River.

TABLE 16. Tagging Summary of Round Whitefish in the Tanana Drainage, 1973.

Round Whitefish Tagging

<u>Location</u>	<u>Dates</u>	<u>Number Tagged</u>
Tanana River		
Section 80	3/27-3/30	657
Section 81	3/30-4/1	904
Delta Clearwater River	4/10-5/18	<u>1,086</u>
Total		2,647

Round Whitefish Recaptured

<u>Location Tagged</u>	<u>Location Recaptured</u>	<u>Number (%)</u>
Tanana River		
Section 80	Delta Clearwater River	3 (0.4)
Section 80	Richardson Clearwater River	2 (0.3)
Section 80	Section 80	<u>2 (0.3)</u>
		7 (1.0)
Section 81	Delta Clearwater River	53 (6.0)
Section 81	Richardson Clearwater River	1 (0.1)
Section 81	Clearwater Lake	<u>1 (0.1)</u>
		55 (6.0)
Delta Clearwater River	Delta Clearwater River	<u>123 (11.0)</u>
Total		185 (7.0)

Intrastream Migration:

In 1973, 1,086 round whitefish were tagged in the Delta Clearwater River. Of these, 123 (11%) were later recaptured in the same stream. General movement trends are depicted in Figure 9. The majority of fish tagged in March and April showed a tendency for upstream migration when later recaptured. This agrees with visual observations. Those whitefish tagged in May showed mixed tendencies, with more downstream displacement than before. This also agrees with observations, as many whitefish (excluded by the week restriction) were recaptured a considerable distance downstream within a few days following tagging operations. Handling rather than normal migration is believed to have caused the displacement.

Abundance:

Table 17 presents estimates of round whitefish abundance in the Delta Clearwater River. As with grayling, the Schumacher-Eschmeyer estimate gives closer confidence limits. It can be seen that round whitefish outnumber grayling by six to one.

TABLE 17. Estimates of Round Whitefish Abundance in the Delta Clearwater River, 1973.

Sample Dates	River Section mi km		Schnabel Estimate	95% CI	RWF Per mi. km.		Schmacher- Eschmeyer Estimate	95% CI	RWF Per mi km	
7/3	17	2	13,664	10,391	854	547	13,611	10,923	851	544
8/15	27	3		21,819				18,056		

Abundance estimates of round whitefish in Sections 80 and 81 of the Tanana River are shown in Table 18. The number of whitefish (14,662) in Section 81 is close to that in the Delta Clearwater River (13,611) just upstream. Based on these data and tagged fish recaptures, it is probable that whitefish in Section 81 move up to the Delta Clearwater River and Clearwater Lake in the summer to feed.

Length Frequency:

Round whitefish length frequencies are displayed in Figure 10. The distribution of whitefish in the Delta Clearwater River appears normal, with a mean at 359 mm.

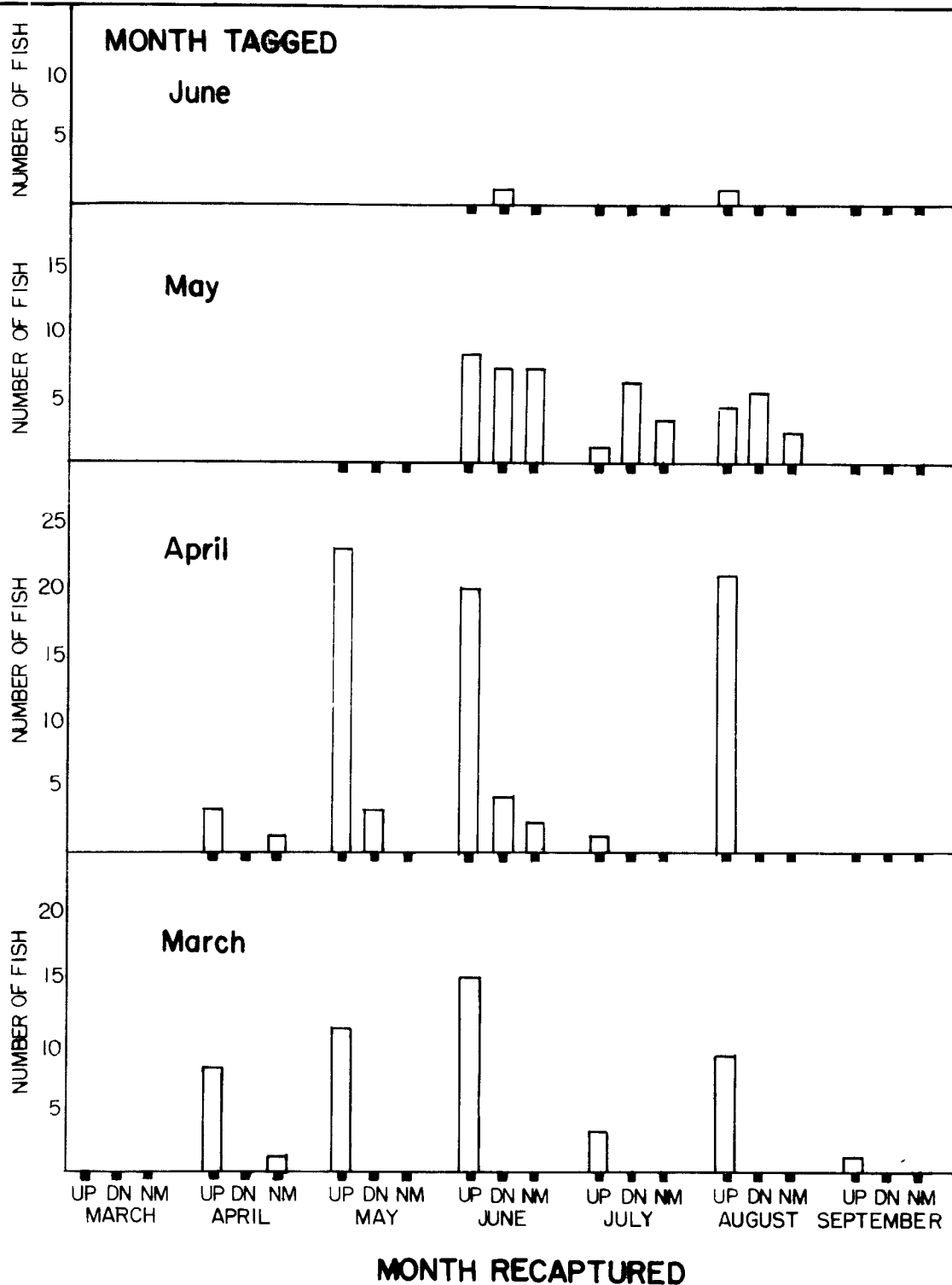


Figure 9. The Restricted* Number of Round Whitefish Recaptured that Moved Up (Up), Down (DN), or Showed No Movement (NM) in the Delta Clearwater River, 1973.

*Excludes recaptures within a week of previous capture.

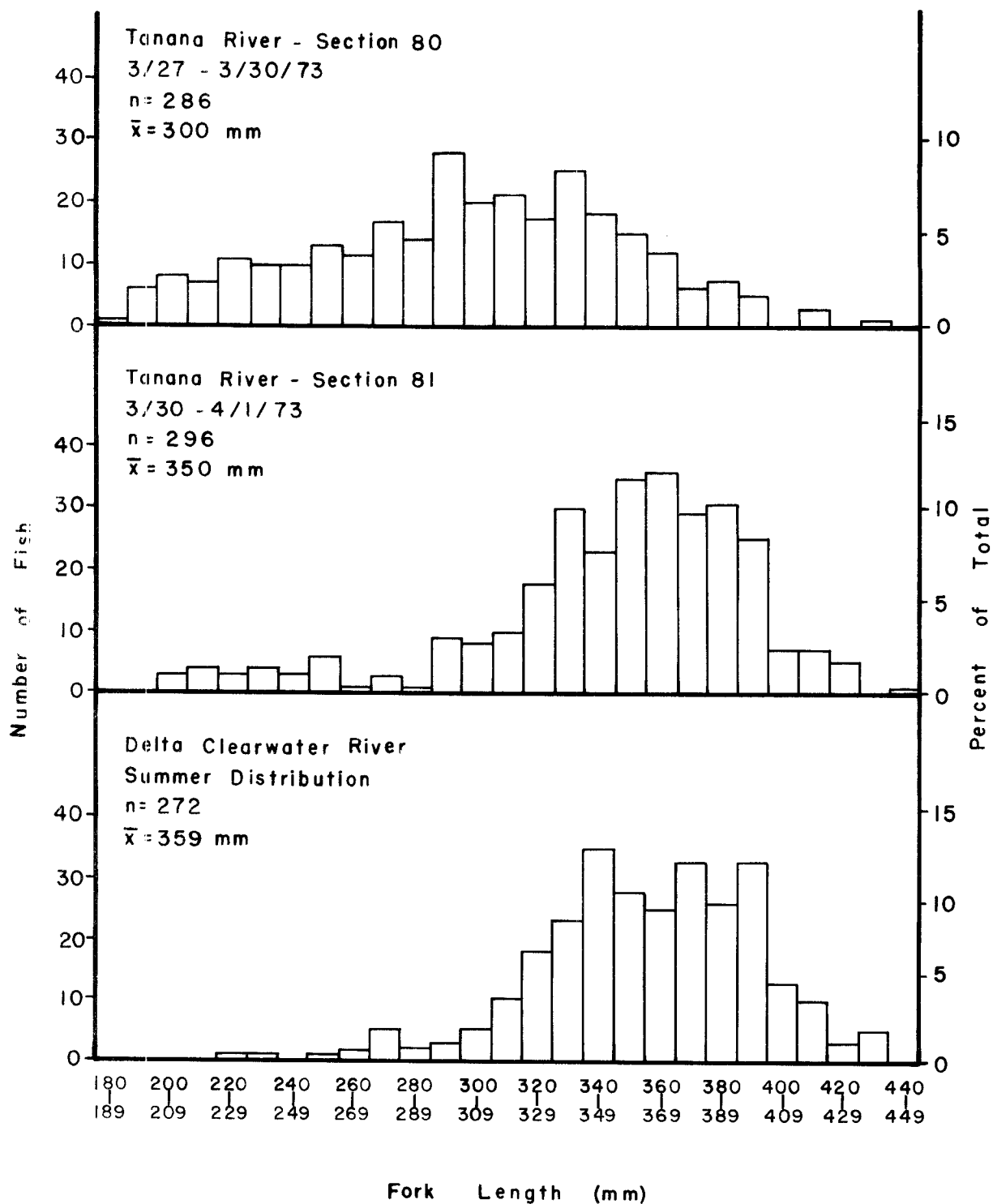


FIGURE 10. LENGTH FREQUENCIES OF ELECTRO-FISHED ROUND WHITEFISH FROM NEARBY LOCALES IN THE TANANA RIVER WATERSHED, 1973.

TABLE 18. Estimates of Round Whitefish Abundance in Sections 80 and 81 of the Tanana River, 1973.

Sample Dates	River mi	Section km	Schnabel Estimate	95% CI	RWF Per mi km	Schumacher- Eschmeyer Estimate	95% CI	RWF Per mi km	
Section 80									
3/27-30	2	3.2	3,924	3,004-6,147	1,962	1,226	2,271-6,589	1,689	1,056
Section 81									
3/30	4	6	14,296	9,814-34,179	3,574	2,383	12,604-17,410	3,666	2,444

The distribution for round whitefish captured below the Delta Clearwater River in Section 81 of the Tanana River follows a similiar trend, with a mean fork length of 350 mm, further indicating that some of these fish probably migrate to feed in the Delta Clearwater system during the summer.

Smaller size classes are represented more frequently in the sample taken in Section 80. There are fewer with a fork length above 340 mm, than in Section 81 or the Delta Clearwater River. The possibility that round whitefish are distributed by size, with smaller fish further downstream in the Tanana River between Sections 80 and 81, is quite good.

Length - Weight Relationship:

The length-weight relationship for round whitefish in the Delta Clearwater River (Figure 11) shows a trend for weight of fish below 350 mm fork length to increase with time. At lengths greater than 350 mm, weights initially increased then decreased. A possible explanation is that the larger, mature round whitefish tend to reduce feeding as August approaches. Stomachs of larger fish collected in August were markedly emptier than those collected in May.

Condition Factors:

Round whitefish condition factors (Table 19) increased with size in the April and May samples, and decreased with size in the July sample. Those fish large enough to spawn would have done so the preceding fall. As opposed to grayling, there was time for a subsequent weight gain during the winter. A possible explanation for a reduction in weight at a given length and therefore a lower K factor in the July sample was the feeding slowdown mentioned above.

TABLE 19. Relative Condition Factors ($K = W/FL^3 \times 10^5$) For Round Whitefish Sampled in the Delta Clearwater River, 1973.

Length Group (mm)	Sample Period		
	4/11-16	5/14-16	7/03-06
190-209	0.851	0.967	1.445
210-229	0.899	0.988	1.377
230-249	0.921	1.007	1.318
250-269	0.939	1.024	1.265
270-289	0.957	1.042	1.218
290-309	0.975	1.059	1.177

TABLE 19. (cont.) Relative Condition Factors ($K = W/FL^3 \times 10^5$) For Round Whitefish Sampled in the Delta Clearwater River, 1973.

Length Group (mm)	Sample Period		
	4/11-16	5/14-16	7/03-06
310-329	0.990	1.074	1.139
330-349	1.005	1.088	1.104
350-369	1.019	1.102	1.072
370-389	1.033	1.115	1.044
390-409	1.047	1.129	1.016
410-429	1.060	1.141	0.992
430-449	1.072	1.153	0.968
450-459	1.080	1.161	0.952

Age Composition and Lengths at Age:

The age composition and length relationship for 120 round whitefish captured in the Delta Clearwater River is shown in Table 20. Age V through VIII fish comprise the bulk of the sample. Fish younger than age V and older than age IX are fewer in number. Determining age of round whitefish scales above age VIII becomes increasingly difficult, as annuli tend to be separated by only two or three circuli. Hence, all fish of age XI and older are grouped. The oldest round whitefish captured was at least age XVI.

TABLE 20. Age Composition and Observed Length-Age Relationships of 125 Round Whitefish Electrofished in the Delta Clearwater River, 1973.

Fork Length (mm)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
180-199			2								
200-219											

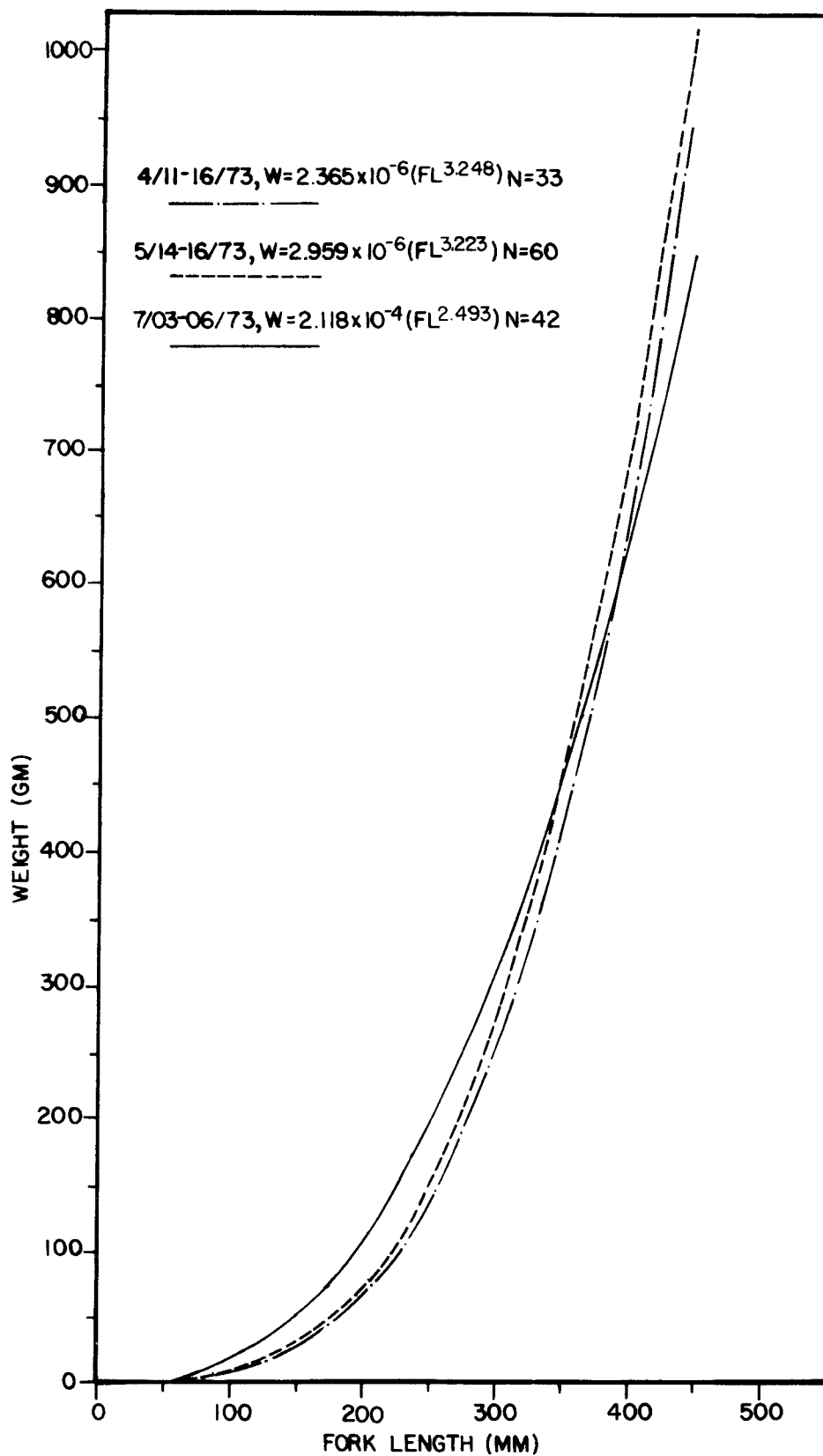


Figure 11. Length-Weight Relationship of Round Whitefish (Sexes Grouped) from the Delta Clearwater River, 1973.

TABLE 20. (cont.) Age Composition and Observed Length-Age Relationships of 125 Round Whitefish Electrofished in the Delta Clearwater River, 1973.

Fork Length (mm)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
220-239			1	2							
240-259			1	2	1	1					
260-279					7	2					
280-299					8	9	2				
300-319						6	6	2			
320-339						5	12	4	1		
340-359						1	15	3	1	1	1
360-379						1	5	5	2	2	1
380-399								1			2
400-419							1		3		
420-439								1			1
440-459									1	2	1
No. of Fish	0	0	4	4	16	25	41	16	8	5	6
Age Comp. (%)	0	0	3.3	3.3	13.3	20.8	33.3	15.0	5.8	5.0	0
Mean Length (mm)	0	0	215	242	275	306	336	357	389	395	0
S.D.	0	0	24	10	15	27	21	31	47	39	0

Back-Calculated Lengths:

Back-calculated lengths and growth increments for round whitefish in the Delta Clearwater system are shown in Table 21. Growth rates decrease with age particularly after age IV. The calculated lengths approximate empirical data presented in Table 20.

Length Distribution:

Round whitefish distribution by length (Table 21) in the Delta Clearwater River followed a pattern similar to that of grayling. Again, smaller fish (less than 300 mm) predominated the lower stream sections. However, fish greater than 300 mm in fork length were captured throughout the system. Only in Sections 15 through 20 of the right fork were fish less than 300 mm fork length absent in the sample.

Sex Composition:

Analysis of data collected from 128 autopsied round whitefish showed males comprised 46% and females 54% of the sample. Sex ratios were balanced up to age IX, after which females predominated.

Maturity:

Fifty-three round whitefish of ages V, VI, and VII from the Delta Clearwater River were examined for maturity. All age V fish were immature. Sixty-six percent of both males and females of age VI were mature, as were all fish age VII and older. Seventy percent of female round whitefish between 290-309 mm and all larger females were mature. Seventy percent of male round whitefish between 290 - 329 mm and all larger males were mature.

The data collected indicates that round whitefish are consecutive spawners as all age VII and older fish sampled showed a development of reproductive products for fall spawning.

During the experimental silver salmon egg take (10/10 - 11/73), 11 round whitefish larger than 333 mm in fork length were autopsied. Seven were females that had recently spawned, one female was still ripe, and three males captured had also just spawned.

During peak silver salmon spawning counts (10/17 - 23/73), fewer than 1,000 round whitefish were observed in the Delta Clearwater River.

Egg Counts:

Limited samples of round whitefish were collected for egg count determinations in the Richardson and Delta Clearwater rivers. A subsample of four fish taken on August 1 from the Richardson Clearwater River showed a mean of 12,529 eggs per female with a range from 9,145 - 17,010. Egg diameters averaged 1.9 mm with a range of 1.8 - 2.0 mm.

A single female taken October 11 from the Delta Clearwater River contained 6,200 eggs with a mean egg diameter of 2.8 mm. This single ripe female was captured in Section 10 along with seven other females that had recently spawned.

TABLE 21. Back-Calculated Length (mm) At Each Year of Life of 64 Round Whitefish, Delta Clearwater River, 1973.

Age At Capture	n	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈	L ₉	L ₁₀	L ₁₁ +
I	0											
II	0											
III	2	97	155	195								
IV	4	80	156	202	242							
V	5	85	147	197	240	279						
VI	9	78	150	193	238	271	297					
VII	19	80	138	190	237	272	299	322				
VIII	9	80	136	187	236	270	301	335	341			
IX	5	88	147	190	235	264	296	326	348	373		
X	4	77	121	168	209	247	275	305	323	351	371	
XI+	<u>7</u>	77	131	175	213	251	283	311	336	355	368	395
	64											
Weighted Mean Length (mm)		81	141	188	233	267	295	322	338	360	369	395
Mean Annual (mm) Growth Increments		81	60	47	45	34	28	27	16	22	9	26

TABLE 22. Percent Occurrence by Fork Length for Round Whitefish Sampled in the Delta Clearwater River, 1973.

Sample Dates	Fork Length (mm)	River Section																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15*	16*	17*	18*	19*	20*	
5/14-5/18	50-99																					
	100-149																					
	150-199																					
	200-249		8	10	3	3		2		15	2		3		2							
	250-299		25	10	10	13	9	16	13		6		7		3							
	300-349		42	52	40	37	50	35	25		34	25	27	7	34	50	52	19	21		10	
	350-399		25	28	40	37	35	38	49	23	40	50	50	79	51	30	41	54	47	38	52	
	400-449					7	10	6	9	13	23	18	25	13	14	10	20	7	27	32	62	38
	Sample Size	12	21	30	30	30	32	43	24	13	50	12	30	14	59	20	27	48	19	8	21	
	*Right Fork																					

The possibility that round whitefish spawn in the Delta Clearwater River, although slim, still exists. No rearing round whitefish were captured. The smallest fish captured was 191 mm fork length and age III. On August 30, numerous ripe round whitefish were captured in Section 81 of the Tanana River. By early September visual observations showed a comparative absence of round whitefish in the Delta Clearwater River. On a trip to the Good-paster River on the 17th, 18th, and 19th of September, 1973, concentrations of pre-spawning round whitefish were observed 50 - 60 miles upstream. Two round whitefish tagged in the Delta Clearwater River were seen in a large school.

Food Habits:

Aquatic invertebrates were collected throughout the Delta Clearwater River system and a faunal list is shown as Table 23.

TABLE 23. Delta Clearwater Faunal List (tentative)

Turbellaria (Flatworm)
 Oligochaeta (Segmented worms)
 Acarina (Water mites)
 Amphipoda (Gammarus sp.)

Insecta

Emphemeroptera
 Baetidae
 Baetis bicaudatus
 Heptageniidae
 Cinygmula sp.
 Emphemerellidae
 Ephemerella (Drunella) doddsi Needham
 Plecoptera
 Nemouridae
 Nemoura sp. (species to be determined)
 Capnia sp. (species to be determined)
 Chloroperlidae
 Alloperla sp.
 Perlodidae
 Isoperla sp.
 Hemiptera
 Corixidae
 Trichoptera
 Rhyacophilidae
 Rhyacophila sp.
 Limnephilidae
 Discosmoecus sp.
 Pycnopsyche sp.
 Caborius sp.?
 Diptera
 Tipulidae
 Dicranota sp.

TABLE 23. (cont.) Delta Clearwater Faunal List (tentative)

Chironomidae	(Genera to be determined)
Tanypodinae	
Diamesinae	
	<u>Diamesa</u> sp. A.
	<u>Diamesa</u> sp. B.
Orthocladiinae	
	<u>Orthocladius</u> sp.
Simuliidae	
	<u>Prosimulium</u> sp.

Stephen L. Elliott of the Alaska Department of Fish and Game, Sport Fish Division, Juneau identified the invertebrates and compiled the faunal list. A Provisional Key to the Aquatic Invertebrates of Delta Clearwater River is on file in the Fairbanks office.

Table 24 presents a limited picture of food preferences versus availability based on two benthic and two stomach samples. Both grayling and round whitefish prefer and possibly compete for the same food items.

TABLE 24. Some Food Preferences of Round Whitefish and Arctic Grayling, Delta Clearwater River, July 5, 1973.

Faunal List	Benthic Samples (2)		Stomach Samples (2)			
	n	%	Grayling		Whitefish	
			n	%	n	%
Turbellaria	3	3				
Oligochaeta	13	8				
Acarina			1	0.05		
Amphipoda						
<u>Gammarus</u> sp.						
Ephemeroptera						
Batidae	37	23	1,092	57	703	72
Heptageniidae	58	35	273	14	228	23
Ephemerellidae					1	0.1
Plecoptera						
Nemouridae	3	2	3	0.2		

TABLE 24. (cont.) Some Food Preferences of Round Whitefish and Arctic Grayling, Delta Clearwater River, July 5, 1973.

Faunal List	Benthic Samples (2)		Stomach Samples (2)			
	n	%	Grayling		Whitefish	
	n	%	n	%	n	%
Chloroperlidae	3	2	2	0.1	3	0.3
Perlodidae			20	1	1	0.1
Hemiptera						
Corixidae						
Trichoptera						
Rhyacophilidae						
Limnephilidae			203	10.5	15	2
Diptera						
Tipulidae						
Chironomidae	23	14	326	17	24	2.5
Simuliidae	1	1	5	0.2		
Exuviae	20	12				

Silver Salmon Life History

The silver salmon investigations in the study area consisted of spawning and outmigrant enumeration, an experimental egg take, and rearing fish sampling. Life history data are presented here.

Two smolt or outmigrant traps were fished continuously from May 25 until June 27 in Section 2 of the Delta Clearwater River. A total of 16 silver salmon was captured, with a fork length range of 78 - 101 mm. Weights ranged from 4.9 - 10.6 mm. These fish were age II. However, their size and capture rate indicate the majority of larger smolt had outmigrated prior to establishing traps. Silver salmon smolts were captured while marking round whitefish in Section 80 of the Tanana River the week in March.

A sample of 24 fry from a spring area in Section 2 showed that they had obtained a mean length of 37 mm and a weight of 0.5 gm by June 14. Another

sample taken from a spring area in Section 6 on July 25 showed that 15 age I salmon had a mean fork length of 71 mm. Weights averaged 4.8 gm for these age I fish. Fourteen age 0 salmon were also captured and had a mean fork length of 35 mm. Weights ranged from 0.4 - 0.7 gm.

It appears that the size composition of these rearing silver salmon is dependent on time of hatching and rearing habitat conditions, i.e., those salmon hatching earlier and occupying ideal rearing areas tend to be larger than those that do not.

Young-of-the-year and age I silver salmon were observed and captured along the stream margins in cover areas during the summer. Some were also captured in spring areas. Fall sampling showed an almost total absence of these rearing fish along the stream margins. They were, however, captured in spring areas in greater numbers than during the summer. The springs tend to maintain higher temperature than the main river throughout the year, and are the preferred overwintering habitat.

Age analysis of 58 adult silver salmon captured in September and October showed all fish sampled to be age 2.1. The mean mid-eye to fork length for males was 560 mm. The mid-eye to fork length multiplied by 1.15 gave the estimated fork length for males. Females weighed an average of 3.4 kg and males averaged 2.9 kg prior to spawning.

Escapement Counts:

In 1973, pre-spawning silver salmon were first observed on September 24 in the Delta Clearwater River. Peak spawning occurred around mid-October and salmon were still present on November 27.

Table 25 summarizes minimum silver salmon escapements in the Delta Clearwater River during 1972 and 1973. The estimated number in 1972 (632) is equal to 19% of those counted in 1973 (3,322). However, the counts in 1972 were made at a later date under poorer conditions. The counts in 1973 were made under peak spawning conditions from an elevated platform mounted on a riverboat, which gave excellent results. Individual fish were easily counted in the clear water.

The relative number of spawners by stream section was similar during both survey years. River Sections 2 of the main river, plus 15 and 16 of the right fork were preferred. Spawning density in 1973 per unit surface area was 25 per hectare or 10 per acre surveyed. No attempts were made to survey salmon above section 18 in the right fork or in any section of the left fork due to impassable conditions for riverboats. The salmon utilize these areas, but to a lesser degree.

An estimated 551 silver salmon spawned in the outlet of Clearwater Lake during the fall of 1973. Young salmon utilize Clearwater Lake as a rearing area. Approximately 350 to 400 silver salmon were also observed in the Richardson Clearwater River.

TABLE 25. Minimum Estimated Silver Salmon Escapements in the Delta Clearwater, 1972 and 1973.

River Section	Salmon Counts	
	11/9/72	10/17-24/73
1	22	132
2	73	532
3	23	43
4	52	227
5	69	151
6	48	79
7	19	22
8	22	222
9	17	52
10	31	154
11	5	170
12	13	131
13	13	215
14	15	217
15*	144	387
16*	26	364
17*	---	218
18*	---	6
Totals	632	3,322

*Right Fork

Over 1,000 chum salmon utilized Mile 1 Slough as a spawning area during the fall of 1973. They entered around the middle of September and peak spawning occurred shortly thereafter. Approximately 40 chum salmon utilized Section 1 and 2 of the Delta Clearwater River for spawning. Four chum salmon were observed in the Richardson Clearwater River with the silver salmon.

Experimental Egg Take - Egg Counts:

An experimental egg take for silver salmon was conducted on October 10 and 11, 1973 in the Delta Clearwater River. Sixty-five females and 32 males were captured by electroshocker boat. Approximately 15 females were green. The egg yield, as estimated by the Fire Lake Hatchery in Anchorage, was 173,700 an average of 3,474 eggs per female, for 50 females. Egg count determinations from ovaries preserved by freezing 4,367 per female, with a range of 3,865 - 5,082 eggs per female; egg diameter averaged 5.5 mm.

Creel Census

The results of non-statistically based angler interviews are summarized in Table 26. Of 315 anglers contacted, total censused effort was 664 angler hours, yielding 436 grayling (0.65 fish per hour). The average catch size was 302 mm (11.9 in.).

TABLE 26. Censused Angler Catch and Effort in the Delta Clearwater River, 1973.

Month	No. of Anglers Contacted	Anglers* Hours	Angler Catch	Catch Per** Hour	Fork Length (mm)	
					\bar{x}	Range
May	147	253	203	0.78	290	180-370
June	104	246	158	0.64	336	220-440
July	51	137	49	0.36	282	210-390
August	<u>13</u>	<u>28</u>	<u>26</u>	<u>0.93</u>	<u>301</u>	<u>250-380</u>
Totals	315	664	435	$\bar{x} = 0.65$	$\bar{x} = 302$	180-440

*Includes only data from Anglers who responded.

**Includes only data when both catch and effort were given.

The total censused catch (436), if added to the population estimate of 2,267, would equal a 16% angler catch, barring any outmigration or natural mortality. Few anglers censused caught their limits.

Table 27 presents a comparison of censused catch and effort for the years 1953 - 1958 and 1973. The censused catch was higher in 1973 than any previously determined. However, the 12 inch minimum size limit in effect from 1955 - 1958 prevented the legal catch of younger, smaller, yet available grayling.

TABLE 27. Comparison of Censused Catch From the Delta Clearwater River, 1953 to 1973.

Year	Anglers Contacted	Angler Hours	Catch	Catch/Hour
1953	300	1,057	307	0.29
1954	48	113	52	0.46
1955*	52	172	126	0.73
1956*	172	680	211	0.31
1957*	102	514	211	0.41
1958*	115	835	259	0.31
1973	315	664	436	0.65

*12 inch size limit in effect from 1955 through 1958.

LITERATURE CITED

- Reed, R. J. Life History and Migration Patterns of Arctic Grayling, Thymallus arcticus, (Pallas), in the Tanana River Drainage of Alaska. Alaska Department of Fish and Game. Research Report No. 2. 30 pp.
- Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Bull. Fish. Res. Bd. Can. No. 119, pp. 81-110.
- Roguski, E. A. and P. C. Winslow. 1969. Investigations of the Tanana River and Tangle Lake Grayling Fisheries: Migratory and Population Study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969, Project F-9-1, 10: 333-351.
- Schallock, E. W. and E. A. Roguski. 1967. Investigations of the Tanana River and Tangle Lakes Fisheries: Migratory and Population Study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1966-1967, Project F-5-R-8, 8: 247-255.
- Tack, S. L. 1971. Distribution, Abundance, and Natural History of the Arctic Grayling in the Tanana River Drainage. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1970-1971, Project F-9-3, 12: p.22.
- Van Hulle, F. D. 1968. Investigation of the Fish Populations in the Chena River. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9: 287-304.

Prepared By:

Approved By:

Gary A. Pearse
Fishery Biologist

s/Howard E. Metsker
Chief, Sport Fish Research

s/Rupert E. Andrews, Director
Division of Sport Fish